NEW AND ADVANCED TECHNOLOGIES IN PETROLEUM AND REFINERY INDUSTRY

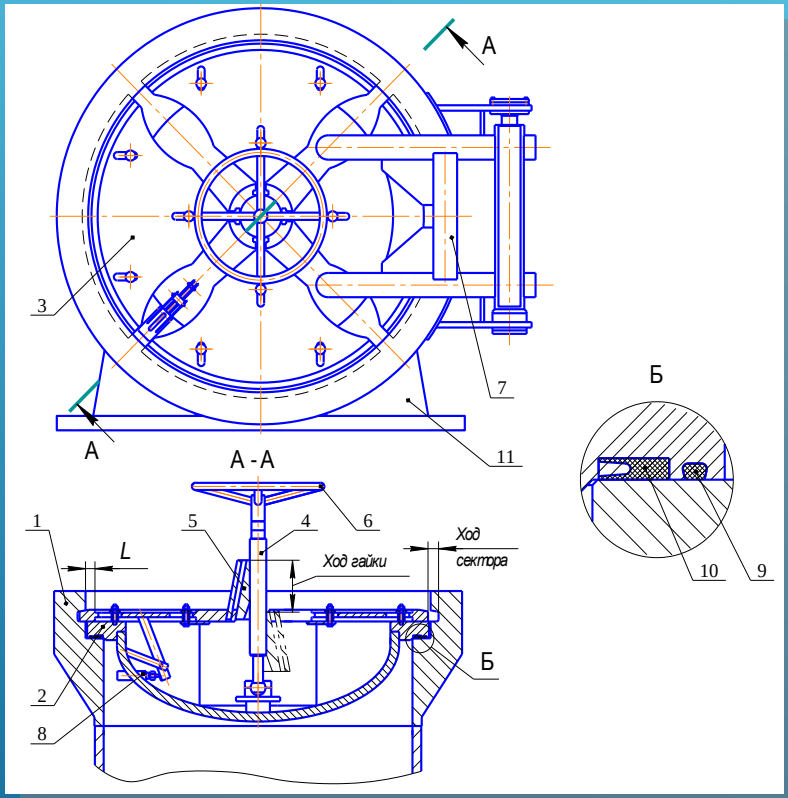
Dr. Ilmer Yu. Khasanov –
Bashkir State University, Scientific and Production Center "Sherik", Russia

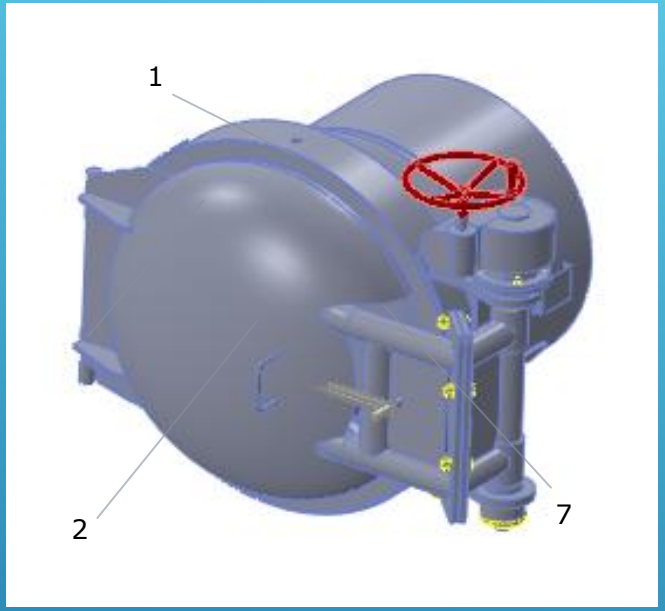
Despite 170 years history of the oil production which made a revolution in development of human society, here are still "entire strata" of unsolved problems, still remaining to be solved. From whole lot of problems, without graduating them in terms of value, I am going to show some, in my humble opinion, long range tasks in several oil and gas business domains at various levels of engineering design maturity. I would be genuinely glad to open, in cooperation with you, the doors to future for products in below-mentioned and other directions.

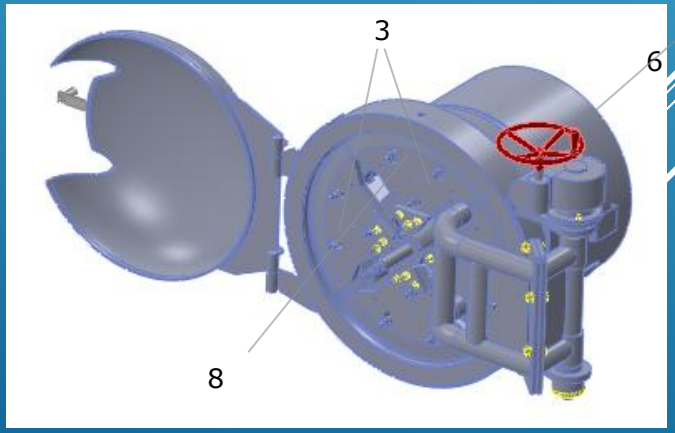
END GATE VALVE

- Succesfully have been developed highly reliable gate valves of ZKSsh type (Quick Acting Sector End Valve) – a new stage in development of equipment for petrochemical industry.
- These type of gates are available for both horizontal and vertical application.

END GATE VALVE FOR HORIZONTAL “APPARATUSSES “

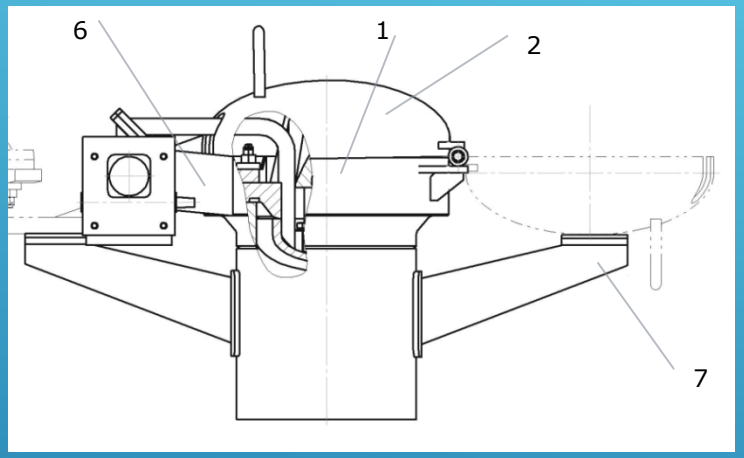


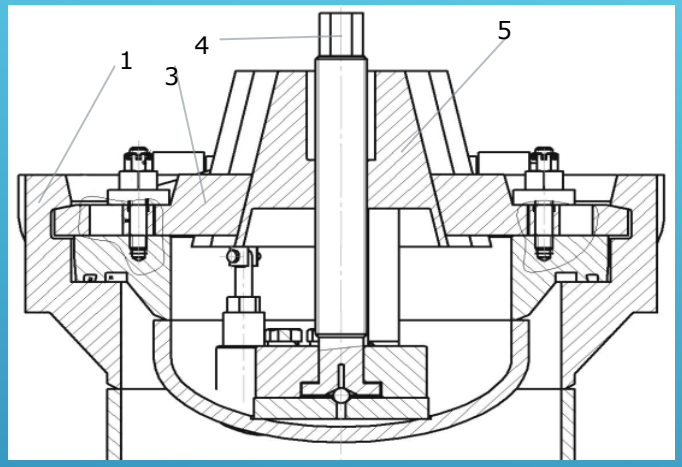


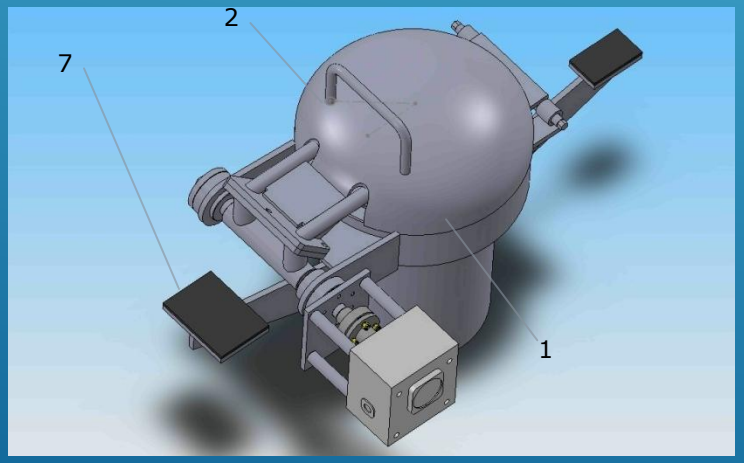


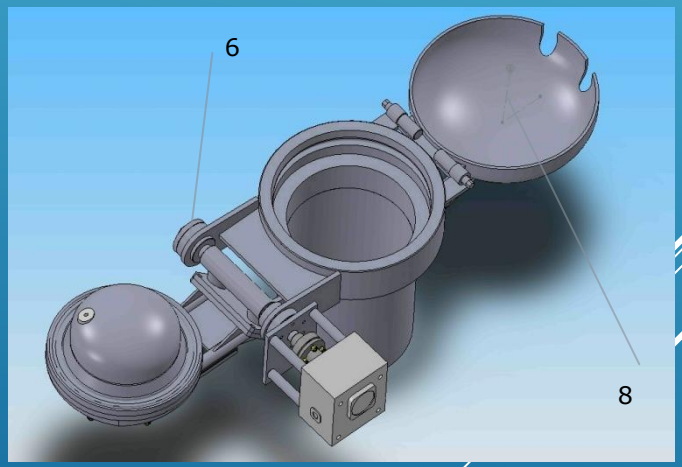
1- flange; 2 – cover; 3 – sector; 4 – screw; 5 – nut; 6– flywheel; 7 – fulcrum arrangement; 8–safety device; 9 – sealing ring; 10 – packing ring

SECTOR END GATE FOR VERTICAL “APPARATUSES”









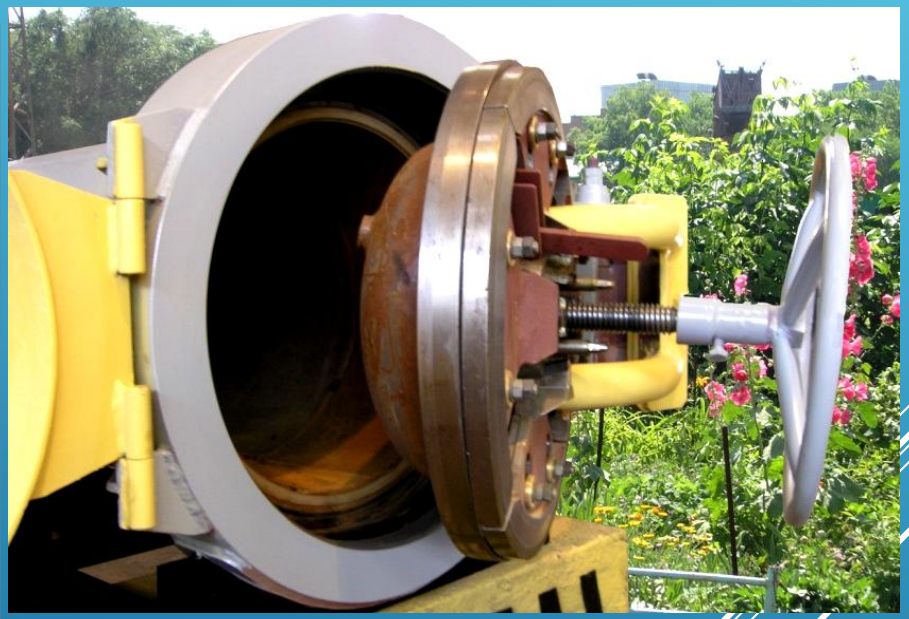
1– flange; 2– cover; 3– sector; 4 – screw; 5 – nut; 6– pivot device; 7 – support; 8 – casing; 9 – sealing ring; 10 –cup-type seal

ZKSSH SECTOR END GATE CHARACTERISTICS

DESCRIPTION	PARAMETER VALUE OR ESTIMATION
Diameters range, DN	from 200
Working pressures range Pop, MPa	1,6…16,0
Working medium temperature, ^{0}C wall temperature assumed	-60…+80 -80…+80
Sealing technique	By jamming the sealing coupled to cup-type seal. Compensation of fabrication inaccuracy and attrition of sectors and boring by the cup-type seal
Opening/closing time, max., min.	7
Working medium	Oil, gas, petrochemical products
Number of lifelong load cycles , min.	1000
Valve opening/closing force, max., N	150
Design evaluation	Moderate ingenuity
Failures, emergences	–
Reliability	High
Availability for valve opening/closing mechanization	Yes
Operating convenience	Friendly
Fire and explosion hazard requirements	Complies
Maintainability*	Convenient
Repair	Not challenging
Safety device	Yes
Unauthorized tampering prevention	Yes
Service life	30
Valve weight, DN/kg	500/790
* - expert assessment	

SECTOR END GATE PHOTOS

Sector end gate at cleaning and diagnostics devices launching/receiving chamber



End gate valve at the manufacturer plant

ACHIEVMENTS

- Gate included into Gazprom PJSC procurement list
- License agreements signed with two manufacturers in the Russian Federation

WORTHWHILE

To implement the gate at all revamped and new installations:

- at oil and gas processing facilities instead of bayonet gates;
- in transportation systems instead of yoke and other type gates;
- at installations of refining and petrochemical companies as well as other branches of industry instead of flange, yoke and other types of gates;

NECESSARY

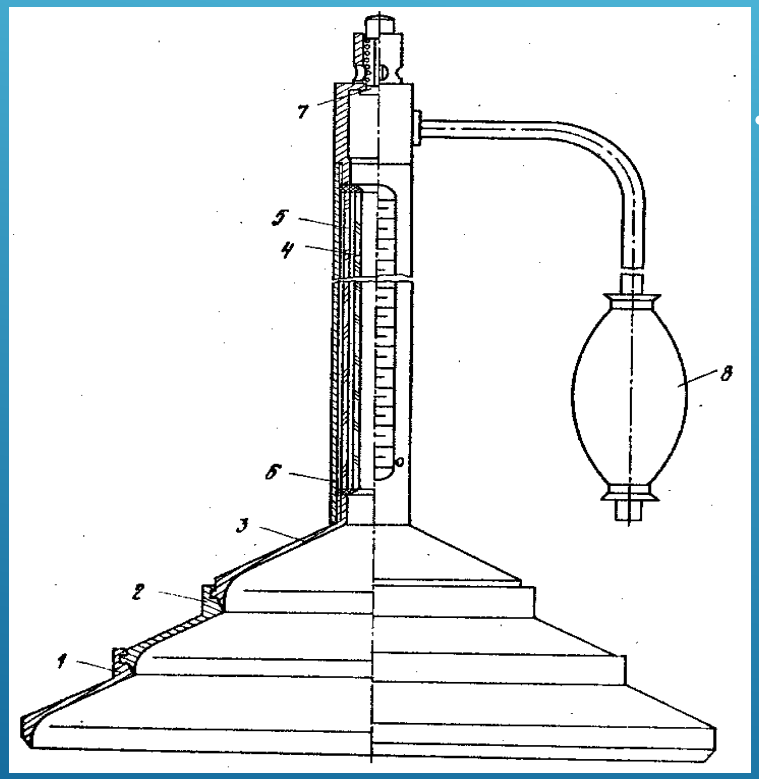
The sector type gates need:

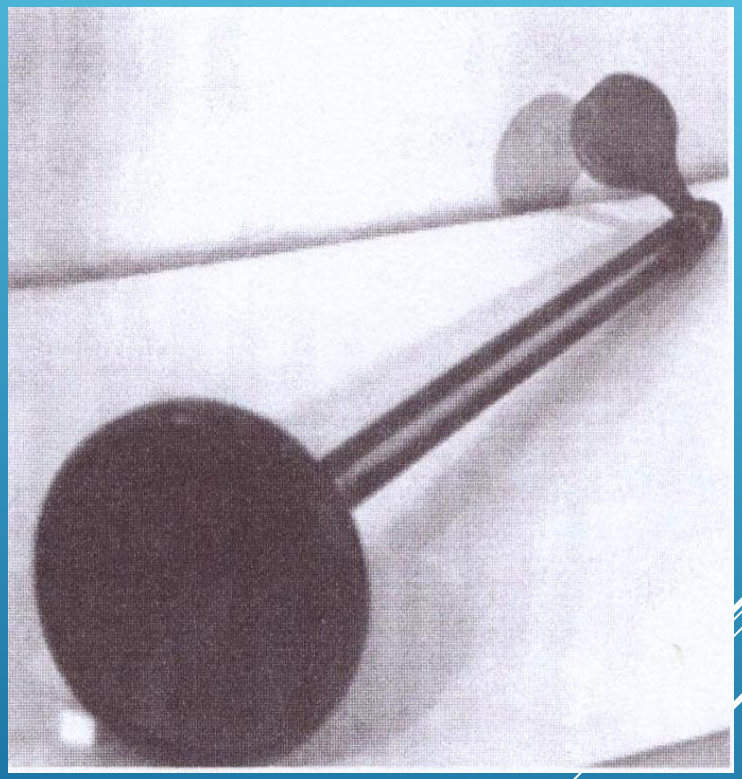
- improvement of design;
- manufacturing process improvement;
- marketing;
- presentation;
- heavily exploit, using all and any possibilities.

APPARATUS FOR RAPID MEASUREMENT OF OIL SPILL THICKNESS

- When oil contamination occurs in the first place it is necessary to identify the volume of spilled oil, its inflow in real-time mode. Nowadays one may quite rapidly and precisely identify the area of any spillage but no device exists for the rapid and precise measurement of thickness of oil spilled on the water body surface. Therefore the estimates of spilled oil amount considerably differ.
- This task may be solved by the apparatus for rapid measurement of thickness of oil spill on the water surface.

METERING UNIT OF THE APPARATUS FOR RAPID MEASUREMENT OF THICKNESS OF OIL SPILL ON THE WATER SURFACE..





1 to 3 – cutoffs; 4 – measuring tube; 5 – scale; 6 – tube case; 7 - valve; 8 – evacuator to produce a vacuum.

MEASUREMENT OF THICKNESS OF OIL SPILL ON WATER BODY SURFACE

- Thickness of oil layer (slick) is determined on condition of the same volumes of oil in the cutoff and in the calibrated tube, i.e.
- $$S_{cutoff} \cdot \delta = S_{tube} \cdot h$$
- then the thickness of oil slick is
- $$\delta = (S_{pipe}/S_{cutoff}) \cdot h$$
- where S_{tube}, S_{cutoff} – cross-section area of tube and cutoff correspondingly;
- h – height of oil column in the tube

CHALLENGES

The device while providing the rapid measurement should be able to:
- register date, time, position data of measurement point;
- register the height of oil column in the measuring tube;
- be fit for simultaneous measuring of thickness and taking of representative sample;
- function during sea agitation (up to set values).

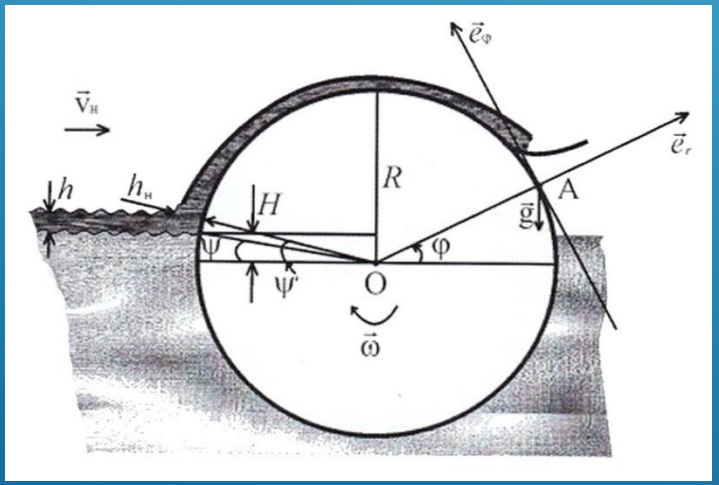
DEMAND

The device will be useful for both oil spillers as well as for the regulatory agencies and authorities

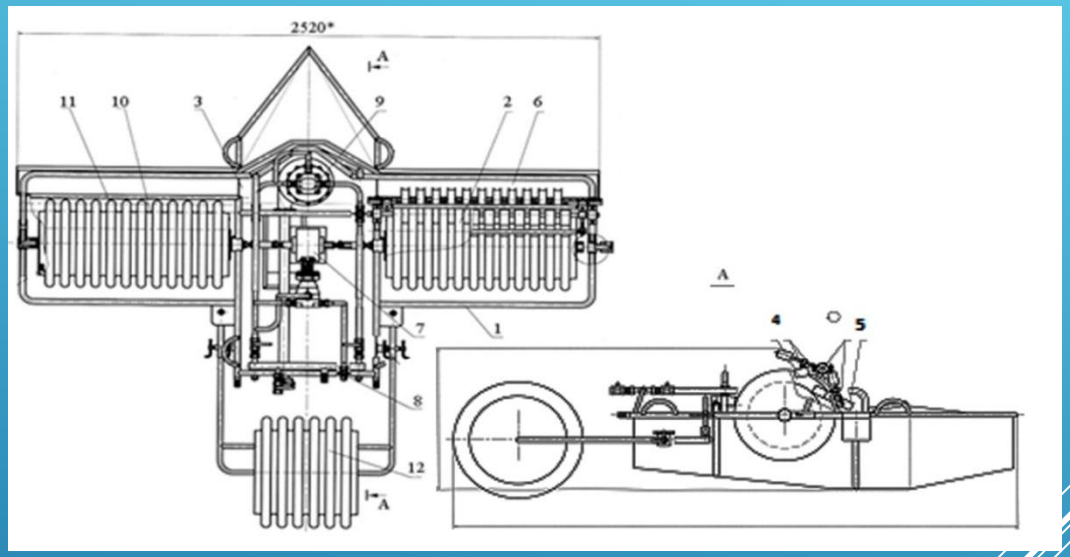
OIL SKIMMER

- There are no oil skimmers capable of collecting spilled oil at low ambient temperatures, specifically viscous and high pour point oil.
- The overflow type oil skimmers with the wave monitoring oil receivers are most practical in the flowing water and during agitation while the adhesive type oil skimmers are more useful at calm water and in low velocity water flows. the oil skimmers of overflow type collect up to 70% or more of oil-carrying water, the oil skimmers of adhesive type collect oil with 3-5% water content or less.

ADHESIVE TYPE OIL SKIMMER



Schematic drawing

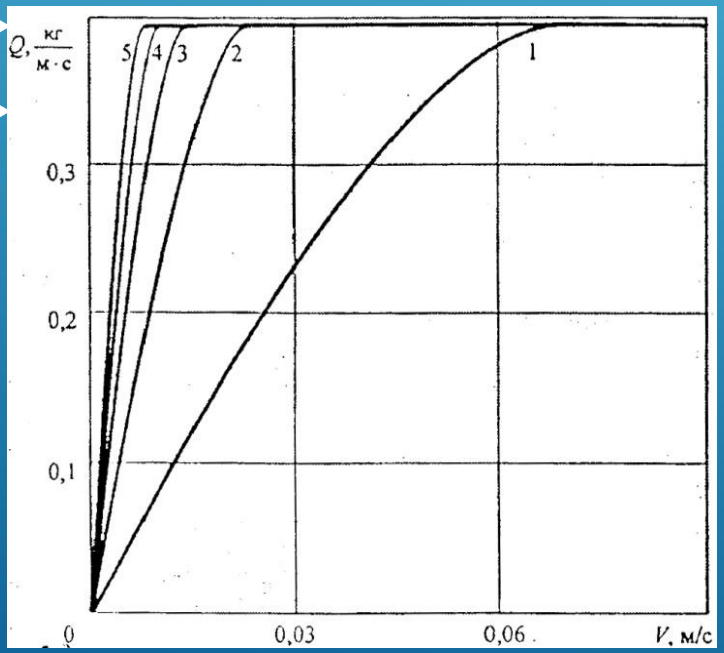


Overall view

1- frame, 2 - rotating drums; 3 - oil receiver,
4 & 5 - scrappers system, 6 - trays, 7 - drums drive,
8 - heating fluid supply unit; 8 – manifold;
9 - pumping unit for collected oil with a drive;
10 & 11 - alternating dents and projections;
12 – float.

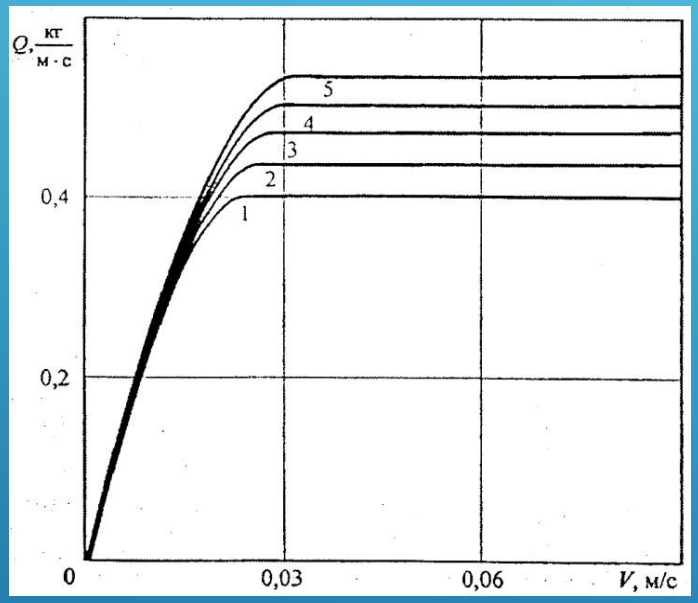
STUDY RESULTS

- We investigated and found solutions for oil gathering drum with a smooth and corrugated, pike-shaped (triangle), П – shaped surfaces [2]. Some results of calculation of the drum with a smooth surface is provided below.
- Calculations are done for parameters as follows: ϱ=850 kg/m^3, R=0.2 m; H=0.1 m; g=10 m/s^2; ν=10^{-5} m^2/s; ω=3.14 c^{-1}.

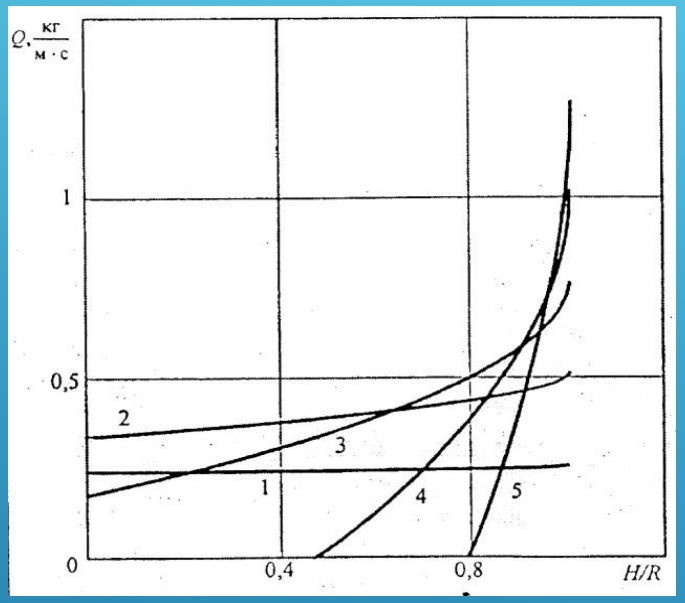


Dependence of unit efficiency on the approach velocity V_H at different h:
1- 0.001 m; 2– 0.03 m; 3 – 0.05 m;
4 – 0.07 m; 5 – 0.09 m.

STUDY RESULTS (CONTINUED)



Dependence of oil skimmer efficiency on V_H at different v:
1 – 10^{-5} m^2/s; 2 – $1.2 \cdot 10^{-5}$ m^2/s;
3 – $1.4 \cdot 10^{-5}$ m^2/s; 4 – $1.6 \cdot 10^{-5}$ m^2/s;
5 – $1.8 \cdot 10^{-5}$ m^2/s.



Dependence of oil skimmer efficiency on H/R at different V_H:
1 – 0.01 m/s; 2 – 0.02 m/s; 3 – 0.03 m/s;
4 – 0.04 m/s; 5 – 0.05 m/s.

MATERIAL SELECTION FOR SKIMMER DRUM

- The key issue during the creation of oil skimmer is the adsorbing capacity of the drum's material, therefore a comparative assessment of adsorbing capacity of solid materials potentially applicable as drum materials has been done. Study fragments are given in the table.

Sample material	Weight of dry sample, G_1, g	Weight of wetted sample, G_2, g	$\Delta G = G_2 - G_1$, g	Surface area, S,cm^2	Adsorbing capacity, g/cm^2	Absolute roughness, R_A, mkm
Steel 3	15.9569	15.9927	0.0358	16,6625	0.0021	1,54…2,50
Low alloy steel	18,3412	18,3812	0.0400	17,3217	0.0023	1,3…2,1
Stainless steel	6,7613	6,7999	0.0378	16.0340	0.0023	0,6…1,0
Aluminum	3.1466	3.1865	0.0399	18.1320	0.0022	0.8…1.1
Polyethylene	0.8458	0.8878	0.0419	17.7660	0.0023	___
Polystyrene	4.4189	4.4696	0.0507	23.0570	0.0022	GOST**

CRITERIA FOR SELECTING THE DRUM MATERIAL

- The choice of material for manufacturing of drum skimmer working surface shall be determined not by the capacity of material “to attract and hold oil on its surface”, but by:
- - the drum manufacturability, ability to manufacture a light rigid unit to ensure positive buoyancy and mechanical strength of the whole structure;
- - resistance to abrasion from contact with scrappers – oil removers;
- - high heat conductivity for heating of external surface and ability of structure to compensate the environment (water, air) temperature changes;
- - corrosion resistance to water solutions of salts, sour and highly sour hydrocarbons;
- - strength;
- - availability and relative low price.

The oil skimmer needs modification to improve its weight/overall dimension characteristics as well as design and production process to be ready for mass production and wide distribution

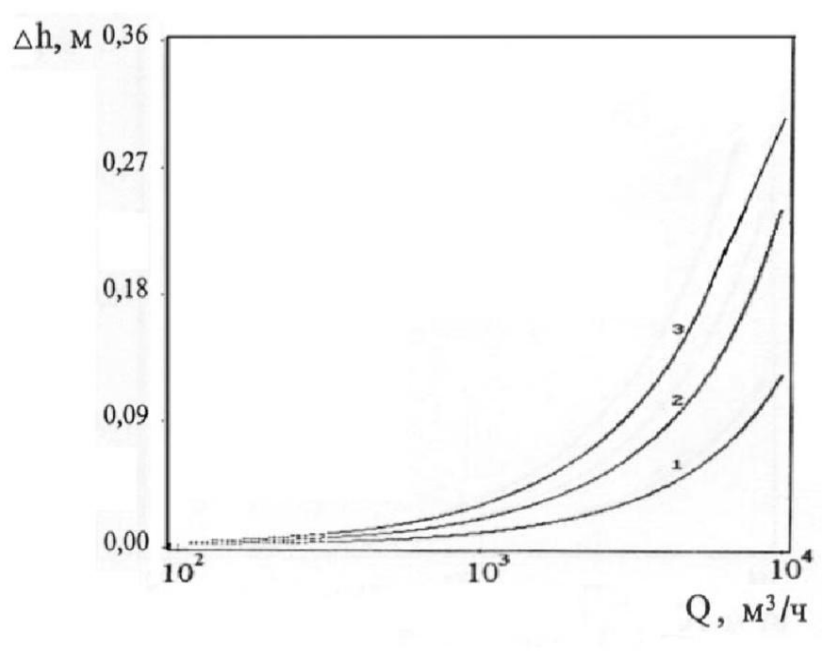
OIL BOOMS UTILIZING AEROHYDRODYNAMICS PRINCIPLE

- The researches showed that notwithstanding of design the maximum flow velocity is described by the equation

$$(11) \quad \vartheta_{max} = 3\sqrt[4]{g \cdot \Delta P \cdot \sigma} \; / \; \sqrt{\rho_{H}}$$

- at which the separate flow of phases oil – water is provided and the “diving” effect is absent i.e. the barrier does not pass the floating oil.
- Where g - gravity acceleration, ΔP – static pressure at the depth of bottom edge of oil boom screen; σ – surface tension at oil – water interface; ρ – oil density.
- The problem is resolved by drift oil booms of aero-hydrodynamic principle – similar to the pneumatic barriers which are used it the oil ports – based on creation of air-and-water ruth.

DEPENDENCE OF WATER-AIR WAVE HEIGHT FROM THE AIR FLOW RATE

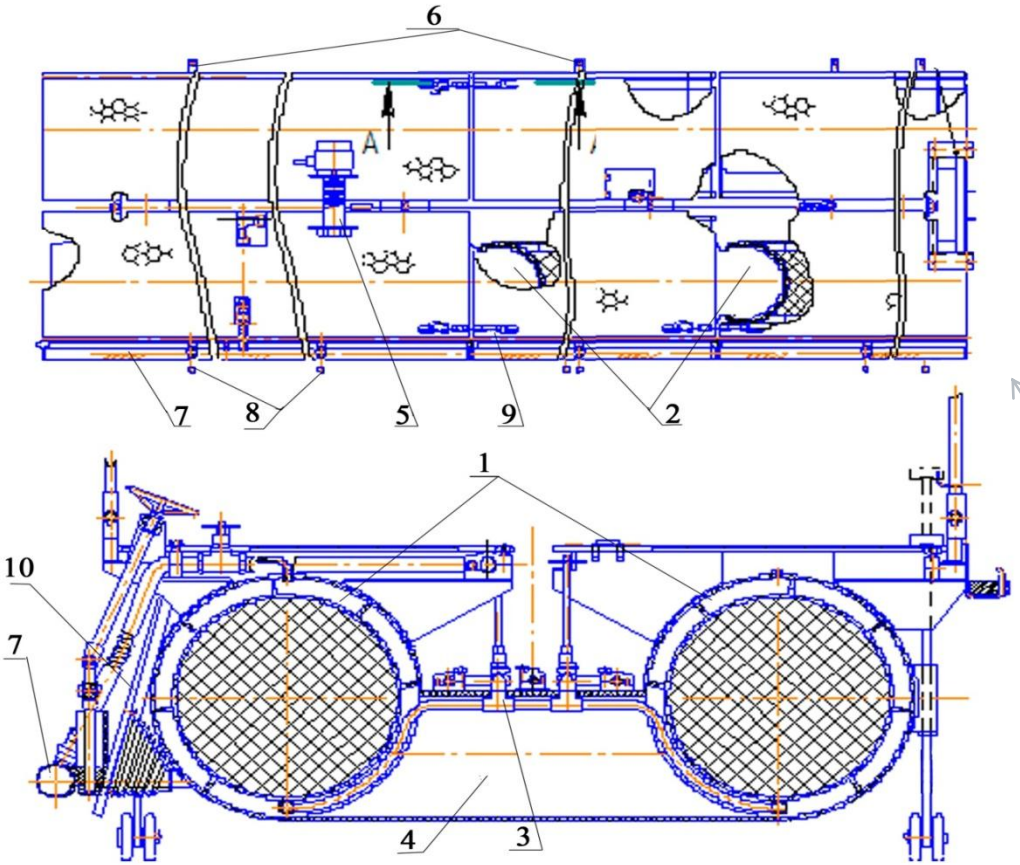


- The figure presents the calculation of average height of water-air wave versus air flow rate (U = 0.3m/s; $1 \cdot h_0$=0.4m; $2 \cdot h_0$=0.8m; $3 \cdot h_0$=1.2m). Thus at half-width of bubble generator l =1, length L =10m, height of its submersion h_0=1.2m and volume of air supply h=10^4 m^3/h the height of water-air wave at the edge of oil slick shall be $\Delta h \approx$30cm.
- …

Vertical view

vation

GENERAL VIEW OF OIL BOOM

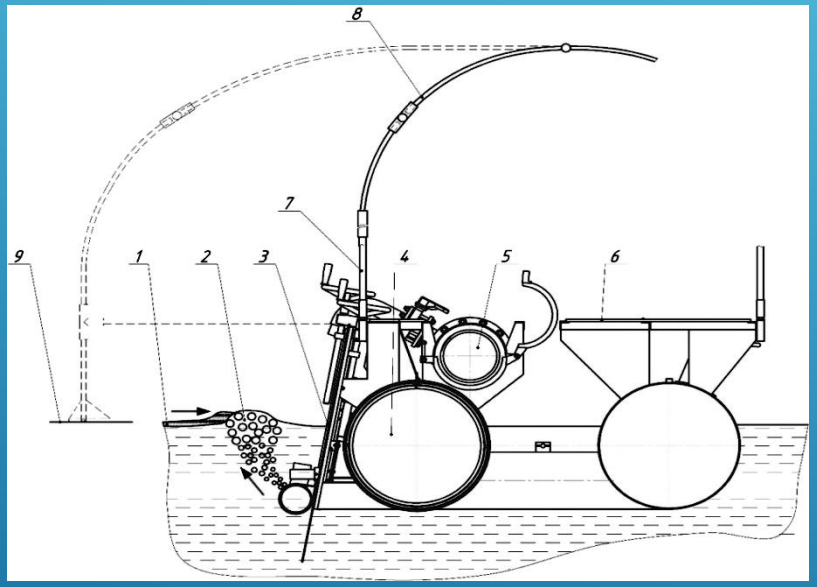


- 1 – shells; 2 – sections docking unit; 3 – heating medium supply line; 4 – bracing; 5 – hoist; 6 – devices for counterweights; 7 – air generator; 8 –containment devices fastening elements; 9 – safety chain; 10 – dampener

Vertical view

Sectional elevation

AEROHYDRODYNAMIC OIL BOOM SCHEMATIC OPERATING PRINCIPLE



1 – oil; 2 – water-air wave;
3 – dampener; 4 – heated shell;
5 – air generator; 6 – service platform;
7 – railing; 8 – roof; 9 – ice surface

- If you are interested in our development results we could jointly improve, manufacture and sale them.
- I see possibilities for their improvement regarding manufacture procedure, improving their reliability and design.


Q&A

THANK YOU !